A CHRONOMETRIC ANALYSIS OF THE EFFECTS OF KAVA

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LIST OF TABLES AND FIGURES

For Leon

Everlasting Love

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ABSTRACT

Posner's (1978) experiment was used to examine the effects on alertness. The experiment, in which the interval between a warning signal and a letter pair was varied and used to examine the effects of alertness, was replicated.

Two such experiments were conducted. The first experiment consisted of a control and experimental group. The experimental group consumed kava at a dosage of 30mg in 250 mls of water prior to the experimental task. The results showed a successful replication of Posner's alertness experiment, however, no effect due to kava was found. Experiment 2 was identical except that the dosage was tripled and added to 500 mls of water. Again the Posner experiment was replicated but no effects due to kava were found.

It was concluded that the rate of preparatory adjustment does not effect the accrual of information to long-term memory as Posner (1978) suggested. Concerning kava, it was concluded that at the dosages employed, kava had no effect, and recommendations for further experimentation are made.

CHAPTER ONE

INTRODUCTION

1. This thesis investigates the effects of kava, a beverage commonly imbibed in the South Pacific, on alertness (Posner, 1978) and the speed with which information can be accessed from long-term memory (Hunt, 1980).

In the following review, a brief history of the concept of alertness as it is used in the context of response time is presented. This is followed by an outline of Posner's (1978) development and refinement of the concept, and of the letter match task which has been used in recent studies of alertness and for measuring time to access information from memory. Finally, kava, or Piper methysticum Forst (piperaceae) shall be described in terms of it's physical attributes and it's varied physiological effects.

CHAPTER TWO

LITERATURE REVIEW

2.1 Alertness

It has been known almost since response times were first used, that latency to a stimulus is affected by the presence of a preparatory warning signal. Traditionally, the interval between a warning signal and the stimulus to which the subject was required to make an overt response was named the foreperiod of a preparatory interval. A subject was said to enter a state of alertness, preparedness, following the warning signal.

Early work investigated the effects of the duration of the foreperiod on response latency. For example, Breitweiser (1911) found that in an experiment in which foreperiods varied at random from trial to trial, reaction times were fastest with foreperiods in the range of 1 to 4 seconds. Telford (1931), however, found the minimum, or fastest, reaction time occurred during foreperiods of 1 second to over 4 seconds. Telford's data also indicated that as the foreperiod is reduced from 1 second to at least .5 seconds, reaction time deteriorates markedly. Woodrow (1914) concluded from his research that a 2 to 4 second foreperiod yielded the fastest reaction times, however, he used only three subjects. Teichner (1954) based his conclusions on those of Breitweiser, Woodrow and Telford. He found the fastest reaction times occurred during a foreperiod of 1.5 to 8 seconds.

Klemmer (1956) was the first to conclude that the fastest reaction can be found during foreperiods of less than 1 second. This was for foreperiods with little variability within that 1 second. He also concluded that reaction time varies with subjects' uncertainty about the time for occurrence of the stimuli.

Bertelson (1967) conducted one of the first studies on the time course of preparation. In his experiments a high uncertainty was created by imposing either a long waiting delay or a variable one. A stimulus was then presented with either a constant foreperiod or without warning. By varying the length of foreperiod he was able to observe the time course of preparatory adjustments triggered by the warning signal. He found that: (a) the time to reach full attention (measured by the most rapid reaction time) can be much shorter than Woodrow's (1914) 2 to 4 seconds, in fact, the full effect on reaction time was obtained after 100 to 150 milliseconds (msecs) further substantiating Klemmer's (1956) results; (b) the warning signal can be used as a time cue to begin preparatory adjustments without a refractory period (period after a stimulus in which responding is delayed), such refractory periods are not the inevitable cost of paying attention to the signal.

Bertelson and Tisseyere (1968) noted Bertelson's (1967) conclusion that information brought about by a warning signal affected reaction after even very short foreperiods. They conducted a similar experiment in order to examine whether Bertelson's (1967) result was contingent on the predictability of the onset of a warning interval. They used two procedures; one using a predictable and one using an unpredictable foreperiod. Their finding was that the time course of preparatory adjustments triggered by a warning signal is the same whether the foreperiod is predictable nor not, that is, foreknowledge of the moment of occurrence of the warning signal is not necessary for efficient preparation to take place, at least when very short foreperiods are used.

In another study, Bertelson and Tisseyere (1969) replicated Bertelson's (1967) previous experiment. A visual, rather than the earlier auditory warning signal, was employed however. Their results were similar and they also found that the warning signal does not start a refractory period but gradually installs a state of heightened responsiveness or preparation.

From the research in the field we can see, firstly, the fastest reaction times (greatest build-up or preparation or most alert) was during a 100 to 150 msec foreperiod (Bertelson, 1967). Secondly, warning signals can be used to start preparation without a refractory period (Bertelson, 1967; Bertelson and Tisseyere, 1969). Thirdly, using very short foreperiods, the shift from preparation to reaction can occur at any time and need not be programmed before preparation is started (Bertelson and Tisseyere, 1968).

More recent research has used these conclusions as a basis for more systematic research on alertness in order to enhance our understanding of the concept.

Posner (1967) in his paper "Chronometic Analysis of Classification" developed a more detailed basis on which subjects classified a pair of letters as being "same" or "different". However, "same" letter pairs could be defined in two ways: either as "Physical Identity" (PI) for example AA, aa or "Name Identity" (NI) for example, Aa, bB.

In the experiment, subjects responded to the letter pair following a warning signal. Subjects responded by pressing the appropriate "same" or "different" key. After each trial they were provided feedback concerning the time taken and accuracy of their response.

The results showed that reaction times for NI and PI matches were faster than for different letter pairs. Reaction times for NI matches were slower than reaction times for PI matches. This NI-PI difference was found to be approximately 70 msec. Error rates were also higher for NI matches than for PI matches.

Posner and Mitchell (1967) and Posner (1978) explained the NI-PI difference as follows. Judgements of physical identity of two forms can be made without recourse to the symbolic meaning of the forms, and therefore without access to any stored information. Judgements of physical identity of completely novel and meaningless forms are made using a "physical code of the stimuli". Judgements of name identity can only be made by those who are literate and know that 'A' and 'a' for example, share a common and more abstract code called a name code. That is, to say that 'a' and 'A' for example are the same required an accessing of knowledge stored in long-term memory whereas two physically identical and completely novel forms can be judged same without recourse to any knowledge as to their meaning.

Posner and Wilkinson (1969) used the letter matching task in an experiment which investigated the effects of a warning interval on response time. A warning signal was followed after a warning interval by a pair of letters. The warning interval was constant for a block of trials but varied between blocks. The subject had a single key which was pressed when the letter pair was defined "same" for that task. "Same" was defined as having physical identity. If the letters were different (e.g., vowels or consonants) the subject did not press the key. Of particular interest is the effect of the warning interval on response time. It was found that the fastest reaction time came after a 500 msec warning interval and the greatest improvement for physical matches was at 150 msecs.

Posner and Boies (1971); Posner, Klein, Summers and Buggie (1973); Gazzaniga and Blakemore (1975) concluded that alertness as tested by the warning interval (time between the warning signal and the appearance of the stimuli) does not affect the rate of build-up of information (accrual of information along sensory pathways) but only the rate at which a later cognitive system responds to that build-up.

This build-up of information begins as the letters appear and reaches an asymptote when the subject is ready to respond. The rate of build-up is related to intensity of the signal (Posner, 1978).
The intensity of the signal does not interact with warning intervals (measure of alertness) therefore, following the logic of additive factors (Sternberg, 1969), alertness and rate of accrual of information

are dependent information processing stages (according to Posner, 1978). With a constant intensity across conditions, if the subject is highly alerted he/she will respond faster on the basis of less accrual or build-up of information, and consequently will make more errors. However, if the subject is less alert (responds slower) he/she will have a greater build-up of information and consequently should make fewer errors. That is, there is a speed-accuracy trade-off (Posner et al., 1973). Posner notes that this relationship of faster response with greater error is the reverse of that usually found in reaction time studies. Normally, long reaction times are associated with greater probability of error in more difficult tasks.

Posner (1978) distinguishes alertness in two ways: firstly, tonic alertness is related to relatively slow changes in alertness during the day and throughout the life cycle. Secondly, phasic alertness (as cited above) refers to rapid, voluntary changes which can be obtained in a laboratory (Posner, 1978).

When a subject is preparing for an incoming stimulus, the following occurs: the EEG shows a temporary blocking of rhythmic alpha activity which is rapidly replaced by desynchronized activity (Lansig, Schwartz and Linsley, 1959), also there is a slow negative drift in the EEG (contingent negative variation or CNV) that begins as rapidly at 100 to 200 msecs following a warning signal and approaches it's minimum at a rate that is a function of the warning interval (Walter, 1964). This CNV occurs as the subject is making preparatory adjustments for an oncoming stimulus and therefore is related to alertness.

Research, as reviewed, has refined the concept of alertness and consequently has increased our knowledge of the cognitive system. For example, we have seen that the rate of preparatory adjustment does not affect the rate of accrual of information, and that the effect of alertness depends upon an ability to place a central attentional mechanism at a heightened state of readiness to respond.

Applications of the NI-PI Difference

The NI-PI difference has been interpreted as the time required to look up or access records in long-term memory (Hunt, 1978). This difference has been used to study firstly, the ageing process (Bisanz et al., 1979) where children and adults were asked to make a physical or name match. The results showed that recognition for a name identity match was slower than for a physical match but this NI-PI difference did not decrease with age.

Secondly, the NI-PI difference has been used to study development (Kraut, 1976). He studied the effects of familiarization on alertness and encoding in children. He found that the familiarization effect (slower reaction time to a stimulus which has had repeated exposure than to a novel stimulus) causes a decrease in alertness associated with a familiar stimulus. With a constant warning interval, reaction time to the familiar stimulus was faster than that of the novel stimulus.

Thirdly, the NI-PI difference has been used to study intelligence (Hunt, 1980). Hunt used the NI-PI difference as a technique for testing speed of an asymptotically learned linguistic association. He used the difference to compare two groups: average young adults with bright university students and average young adults with educable mental retardates. He found the NI-PI measure revealed similar results to the aptitude tests used.

Chronometric Analysis of Kava

In the present thesis, two main aspects will be involved: firstly, alertness or willingness of central mechanisms to respond, and the rate of accrual of information along sensory pathways, hence accumulation or build-up of information over time.

Secondly, the NI-PI difference will be studied with reference to the Fijian beverage, kava.

2.2 Kava

Kava or Piper Methysticum Forst (piperaceae), a member of the pepper family, is a perennial shrub indigenous to many islands in the South Pacific (Buckley, 1967). It's physical appearance consists of a long stem, heart shaped leaves, knotty branches and small flowers. It grows to about three metres over a period of 3 to 4 years (Hansel, 1968).

The plant has been used to prepare a beverage known as kava, kawa, or awa. Preparation in the islands is usually achieved by chewing the root, spitting it into a bowl, adding water to it and straining it. Kava has been consumed in many islands, originally in conjunction with religious ceremonies (Buckley, 1967).

Kava has been observed to have a number of effects on the nervous system, including (a) analgesic resulting in numbness of the tongue, mucous membrane, cornea and conjunctiva, (b) producing a soothing effect and removal of fatigue, (c) allaying thirst and stimulation of salivation and perspiration, (d) diuretic and sedative of sexual excitement, (e) paralysis of sensory nerve endings and distortion of perception with larger doses, and (f) paralysis of the motor centres of the spinal cord, depressing and diminshing reflex action (Degener, 1949; Hansel, 1968; Lemert, 1967; McPherson, 1921).

Due to the paucity of empirical research there has been a lack of agreement concerning kava's constituents and actual pharmacological effects. For example, Meyer (1967) stated that there are six known pyrones (constituents) in kava, all of which are pharmacologically active. This, however, has been disputed by Hansel (1968) who argues that there are 12 pyrones but is uncertain whether all are pharmacologically active.

Studies on laboratory animals have attempted to further advance our knowledge of the pharmacological effects of kava. Buckley (1967) found depressed spontaneous motor activity related to dose but no alteration of motor activity in mice placed on a rotorod. Meyer and Kretzschmar (1966) produced muscular relaxation by separating some of the constituents and dosing animals. In addition, they suggested that kava pyrones are potential centrally acting skeletal muscular relaxants. Singh (1982) showed that kava causes paralysis in the skeletal muscles by mechanisms similar to local anaesthetics.

Meyer (1967) stated that various constituents of kava produce ataxia and ascending paralysis without a loss of consciousness. He also noted that doses which produce a blockage of spinal reflexes have little effect on the electroencephalogram and left EEG arousal from stimulation of the midbrain reticular formation unimpaired.

Buckley et al. (1967), however, stated that certain constituents caused a moderate slowing of cortical, hypothalamic and hippocampal activity with ataxia and motor deficiency. After the cortical activity had returned to pretreatment levels, subcortical (hypothalamic) activity was reduced, as shown by the absence of EEG arousal. This latter finding was supported by Kretzschmar et al (1971) who stated that the sedative effect of the drug in man, probably, is the consequence of both the depression of muscle tone and depression of the cortical activation system and limbic areas by the pyrone compounds.

There is then, an uncertainty as to whether and to what extent kava affects the higher central nervous system.

Singh, Bakker and Singh (1983) studied the effect of kava on vigilance, memory, hand-eye co-ordination, reaction time and balance. The dosage used was 30 grams of kava per 500 mls of water. No significant effects due to kava were found and they concluded that this may have been a consequence of the low dose used.

EXPERIMENT 1

3.1 METHOD

Design

The experiment involved a kava and a non-kava group, each consisting of 9 (4 female and 5 male) undergraduates who were naive regarding the purpose of the experiment and the effects of kava. Subjects were randomly assigned to the groups.

Each group completed the experimental task on two occasions which on average were 3 days apart (range was 1 to 6 days). The kava group was given kava to drink 30 minutes prior to completing the task but only on the second occasion.

Kava Preparation

The kava root in powder form was obtained from the island of Tavenui (Fiji). 30 mgs was added to 250 mls of water. This was filtered through a piece of fine cotton material. The residue was discarded and enough water was added to make a total of 250 mls. The mixture was again filtered through the cloth. The resultant liquid was used as the kava beverage in the experiment.

In the islands, kava is made by a similar method. However, for ceremonial purposes the kava root is not ground into a powder, rather, it is chewed and spat into a container ready for the addition of water, as mentioned in Chapter 2. The method for preparation used in this experiment is similar to that when kava is used for social, non-ceremonial drinking.

Apparatus and Stimuli

An Apple II Plus computer displayed the stimuli via a 14 inch Kaga KS14P colour monitor and controlled the time intervals, recorded response times and displayed feedback. Software timing procedures outlined by Price (1979) were used to time intervals and responses to within one millisecond accuracy. Timing routines were synchronized to the monitor frame rate following the method outlined by Cavanagh and Anstis (1980). Responses were made using morse keys connected to the computer key board via the numeric key pad interface.

Each trial began with a composite visual and auditory warning signal. This was followed by an empty interval, a letter pair and after a response, time and accuracy feedback. The warning signal consisted of a 50 millisecond burst from the Apple bell and a concurrent cross of arm width 15mm which was displayed in the centre of the screen. The cross was constructed using the Apple's High Resolution Graphics capability and had a stroke width of 15mm. During so-called blank intervals a single high resolution graphics dot was displayed in the centre of the screen to act as a fixation point.

The warning interval was the time between the onset of the warning signal to the onset of the letter pair. Warning intervals of 50, 90, 190, 490, and 990 msecs were used. Where the warning signal exceeded 50 msecs, the screen remained blank between the offset of the warning signal and the onset of the letter pair. In order to synchronize timing routines to monitor frame rate, time intervals following that of the warning signal had to be in intervals of 20 msecs, hence warning intervals were not multiples of 50 mses. The 50 msec warning signal duration was chosen because Posner et al (1971) had found it effective.

The letters F, f, G, g, R, r, Y, and y were used. They were divided into physically identical (e.g., FF), name identity (e.g., Ff) and different (e.g., Ry) letter pairs.

The stimulus set consisted of 8 physically identical, 8 name identity and 16 different letter pairs. Each pair was presented twice at each of the 5 warning intervals to give (8+8+16)x2x5=320 trials. The order of presentation of these trials was completely random except that within each block of 20 trials, there was one physically identical, one name identity and two different pairs at each warning interval. In addition, 40 trials were generated as practice trials so that subjects completed a total of 360 trials.

Letter pairs were constructed from a standard 7x9 ASII Character Font which generated letters by using the computer's high resolution graphics capability. At a viewing distance of 1 metre the letter pairs and feedback information cast a horizontal visual angle of 1.43° while that for the warning cross was $.86^{\circ}$.

The morse response keys were labelled "same" and "different" and were placed one under the index finger of each hand, the preferred being used for different responses.

Following a response, either the response time in milliseconds, or the word "ERROR" was displayed for 1 second. This was followed by the fixation point in the centre of the screen. It remained visible during the intertrial interval until the commencement of the warning signal. Intertrial invervals varied at random between 2 and 5 seconds.

3.2 PROCEDURE

Non-Kava Condition. Subjects sat in front of the monitor and were given an instruction sheet. This informed them that firstly, a dot would appear on the screen followed by a concurrent bell sound and a visual cross, secondly, a letter pair would be displayed. Subjects were instructed to make their response by depressing the appropriate morse key. It was stressed that subjects respond as fast as possible with minimum errors. Thirdly, a feedback display would appear, informing subjects of time taken and accuracy. The experiment lasted for 35 minutes.

Kava Condition. Prior to the second experimental session subjects consumed the kava and waited for half an hour in order to allow enough time for absorption. No information about the pharmacological effects of kava was given.

3.3 RESULTS

The experimental task is similar to that of Posner et al. (1967) as previously mentioned but it differs in that warning intervals have been randomized rather than blocked. Therefore, it is important to establish whether the non-kava group (controls) replicate Posner's basic findings of name identity condition yielding slower reation times for all conditions; decreasing with warning intervals to reach a minimum reation time with a warning interval of around 500 msecs.

Any effects of kava on alertness and memory access would be realised by a significant groups x sessions x type of match interaction and in a groups x sessions x warning interval interaction in a groups x sessions x warning interval x type of match analysis of the data. In analyzing the data, all reaction times less than 50 msecs were treated as anticipation errors and rejected, and all reaction times greater than 3000 were regarded as resulting from attentional lapses and were likewise rejected. The median of the remaining and correct reaction times was found for each subject for each kind of match, at every warning interval in each session. Medians were used because they are less affected by outlying observations. The medians were treated by a groups x sessions x warning interval x type of match ANOVA with repeated measures on the last 3 factors.

Of relevance for assessing the effects of kava, the groups x sessions x warning interval and groups x sessions x type of match effects did not approach significance, in fact no effects involving the groups and sessions factors approached significance. However, there was a strong type of match effect $F(2,32) = 73.92$, $p<0.001$, and a pronounced warning interval effect $F(4.64) = 30.47$, $p<0.001$.

Reaction times, pooled over groups and sessions are displayed in Figure 1 as a function of type of match and warning interval. The graph clearly resembles Posner's findings. First, it is clear that "same" responses are made much faster to physically identical than to name identity letter pairs. This is consistent with Posner and Mitchell (1967) and Posner and Boies (1971). Second, as Posner and Boies noted, all types of match yield their fastest reaction times with a warning interval of about 500 msecs with the fall in reaction time with warning interval being greatest during the first 200 msecs of the warning interval. Examination of the graph suggests this result occurred for physically identical, name identity and different letter pairs but that the effect of warning interval was less pronouced for "different" data. This probably accounts for the small but significant type of match x warning interval interaction $F(8,28) = 4.63$, $p<0.001$. Posner and Boies (1971) observed a similar effect. No other main or interaction effects approached significance.

Figure 2 presents the percentage of trials in each condition, pooled over the experimental sessions and groups, in which subjects made an erroneous response. The overall error rate was 12.0% which compares favourably with that of about 12% reported by Posner and Mitchell (1967). Different and name identity pairs were much more commonly misidentified than physically identical pairs, and errrors were more common at the shortest warning intervals. These findings are consistent with those of Posner and Mitchell (1967) and Posner et al. (1973).

The conclusions to be drawn from this experiment are clear. Firstly, the alerting function of decreased reaction time with increased warning interval, and the level of match effect of faster "same" reponse to physically identical than name identity letter pairs has been

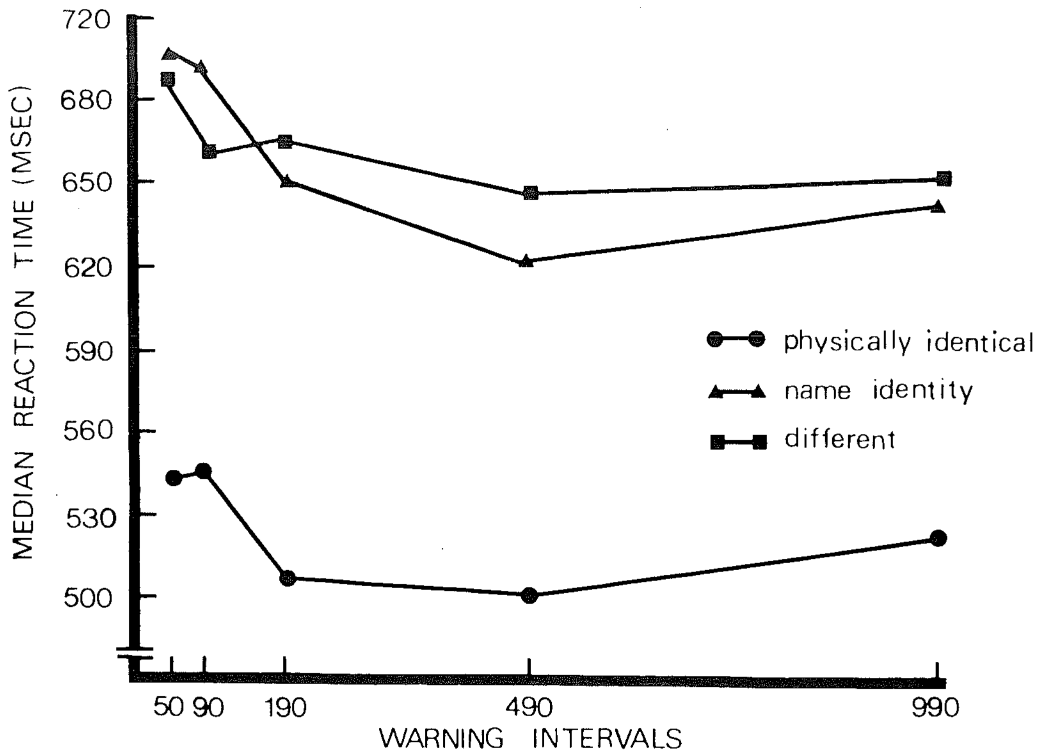

FIGURE 1 : median reaction times pooled over groups and sessions

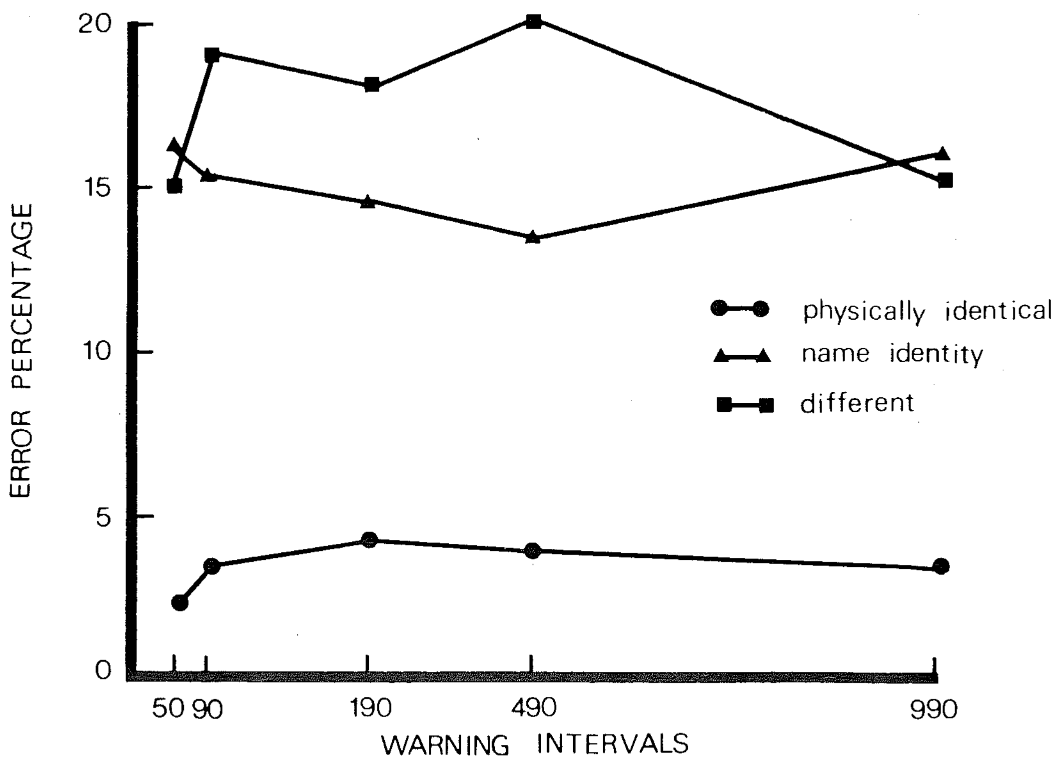

FIGURE 2: percentage of errors pooled over groups and sessions

replicated. Secondly, kava at least in the quantities consumed has had no effect on absolute reaction times, on alerting, or the NI-PI difference, or speed of memory access (Hunt, 1978). Singh, Bakker and Singh (1983) also failed to find any behavioural effects on a variety of tasks using the same dose levels.

Because of the failure to find any effects of kava, a second experiment was run using the same task but with increased kava levels adjusted for body weight.

EXPERIMENT 2

Method

The method and procedure were identical to those of Experiment 1 except that only a kava group was run, the dosage of kava was increased to 1mg of kava root powder per kg of body weight, approximately triple the earlier dose, and the water content was increased to 500 mls in order that an identical kava to water solution could be ensured. Subjects were instructed to wait a period of 1 hour before commencing the experiment in order to allow sufficient time for absorption. The non-kava group of Experiment 1 served as controls for this experiment also.

Results

The "different" data were not analyzed as they are not necessary for the assessment of alerting or speed of access from long-term memory. In all other respects the treatment of data is identical to that of Experiment 1.

The results of a groups x sessions x warning interval x type of match analysis revealed no significant main or interaction effects involving the above groups factor. However, there was again a strong type of match effect $F(1,16) = 105.2$, p 0.001 and warning interval

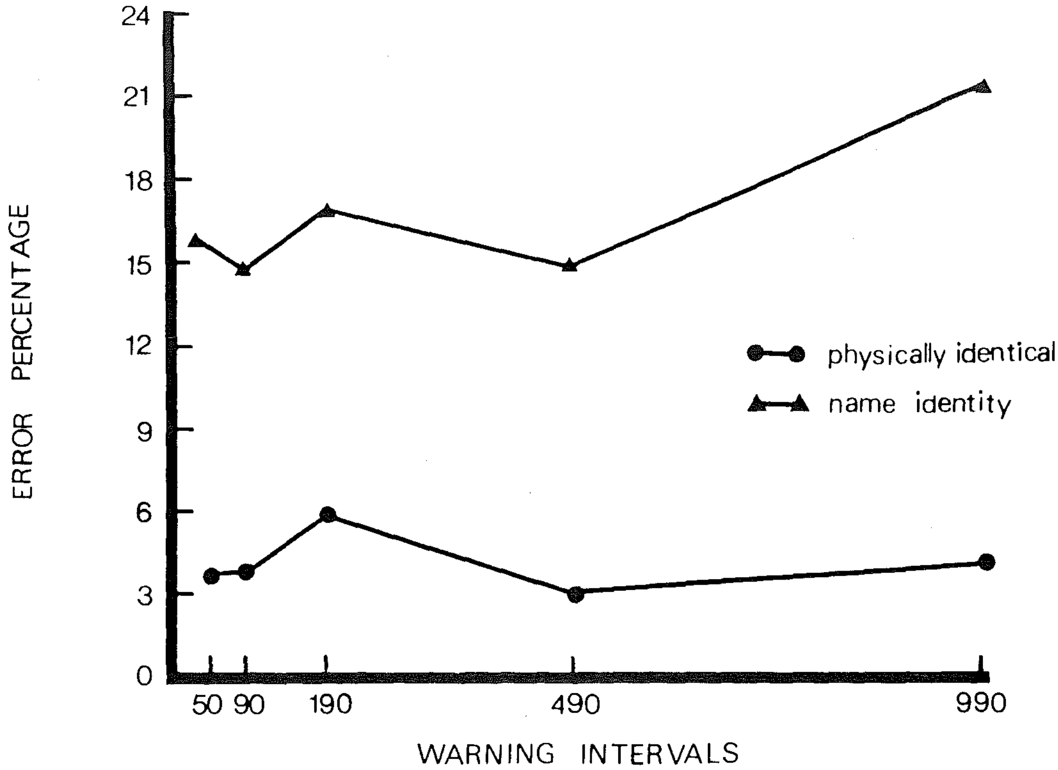

FIGURE 3 : percentage of errors pooled over groups and sessions

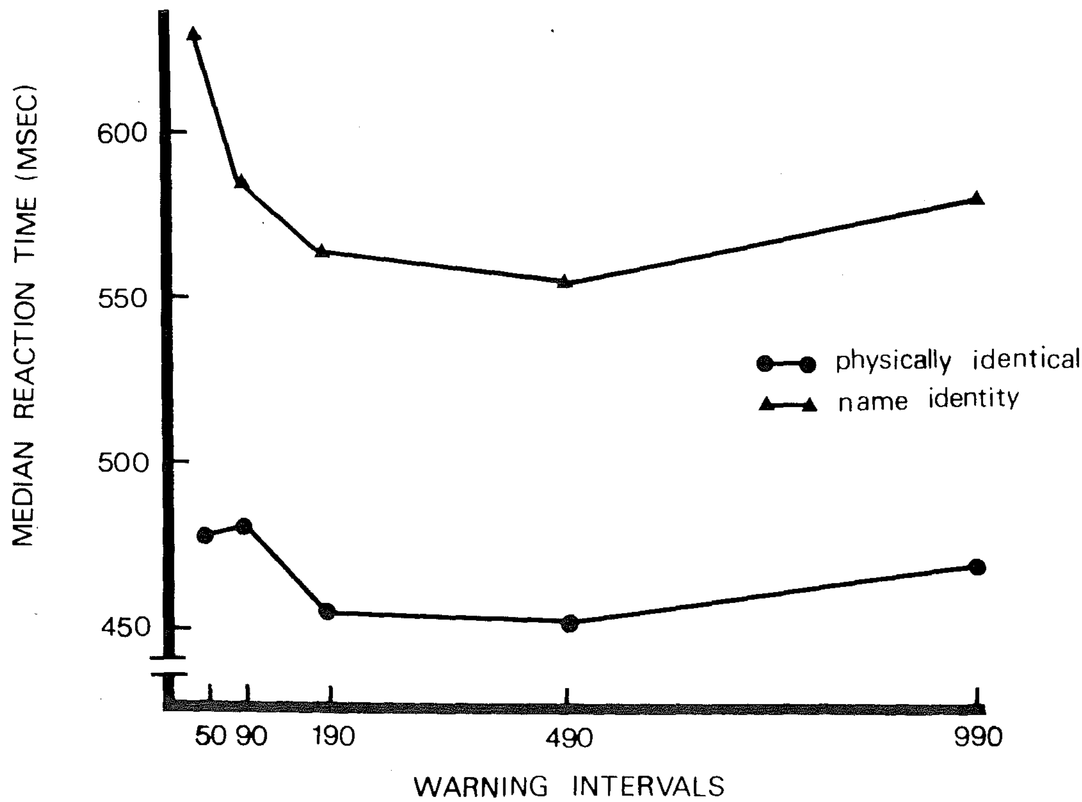

FIGURE 4 : median reaction time for kava group pooled over sessions

effect $F(4,64) = 25.77$, $p<0.001$. A significant sessions effect was also found $F(1,16) = 13.75$, $p<0.001$. No other main or interaction effects approached significance. In both experiments reaction times were faster on the second session but only that of Experiment 2 reached significance.

The reaction time trends in Figure 4 are all consistent with those of Figure 1 for Experiment 1 and again follow the patterns reported by Posner and Mitchell (1967) and Posner and Boies (1971).

The percentage of trials with erroneous responses is expressed in Figure 3, that is, name identity mismatches were again more commonly made than physically identical mismatches. The overall error rate for Experiment 2 was calculated at 10.6% which again compares favourably with Posner and Mitchell's (1967) 12%.

The conclusions to be drawn from Experiment 2 parallel those of Experiment 1. Kava, even at a dose quite significantly above that thought to be encountered socially in the South Pacific, has had no effect on absolute reation time, alerting, or speed of memory access.

DISCUSSION

The purpose of this thesis was to ascertain whether the consumption of kava led to a change in the speed of access of information in memory and/or the degree and time course of alerting as measured by Posner's simultaneous letter match task with variable warning intervals. However, before the results can be interpreted in terms of the concepts of alerting and speed access, etc., it is necessary to establish that the reported findings of NI-PI difference in reaction time, and decrease in reaction time with warning interval, have been replicated.

It is clear that the alerting task used in the present thesis has been a successful replication of Posner's earlier experimentation. The results found are similar to those of Posner and Mitchell (1967);

Posner and Boies (1971) and Posner (1978) despite a difference in method (in Posner et al's experiments warning interval was constant across a block of trials, whereas in the present study they were randomized across trials). Following Posner (1978) it may be concluded that (1) the rate of preparatory adjustment does not effect the build-up or accrual of information, (2) the effect of alertness depends upon the ability to place a central attentional mechanism at a heightened state of readiness to respond and (3) more specifically, in order to make a name identity match there is an accessing of knowledge stored in long-term memory, whereas, in making a physically identical match, no recourse to any stored knowledge, as to meaning, is needed (Posner and Mitchell, 1967; Posner and Boies, 1971).

Previous research into kava has revealed significant effects relating to experimental manipulation, e.g., Buckley (1967); Degener (1949); Hansel (1968); Kretzschmar (1971); Meyer (1967); Singh (1982). The effects of kava, as found by these authors, were in peripheral neuromuscular sedation, and slowing down of CNS functioning with a decrease in effect towards higher CNS functioning. Therefore, it was expected that slowing down of reaction times would occur in the present experiment. However, kava had no statistically reliable effects on reaction time in the present experiment. Several reasons for this can be given.

Firstly, Singh, Bakker and Singh (1983) (who also found no significant lengthening of response latency) concluded that the dosage may still have been too small to affect any change. In addition they suggested that since subjects knew they were consuming kava, their motivation towards the task may have increased and thus countered any mild effects the drug may have had.

Secondly, a further difficulty was the lack of control for food intake in the present experiments. Because the subjects differed in the time tested, e.g., before of after meals, it was not known what effect food may have had on the uptake of kava into the vascular system from the gut.

Thirdly, in the current thesis there was no separation of the constituents of kava, rather the raw material was used, that is, the ground up powder from the kava root. Previous researchers, however, found various effects when they used the isolated active kava constituents. For example, Buckley (1967) separated 3 kava pyrones and injected them into rats. This resulted in a slowing of cortical, hypothalamic, and hippocampal activity with concommitant ataxia and motor deficiency. Meyer (1967) separated 6 kava pyrones and injected them into mice. This produced muscle relaxation and larger doses produced ataxia and ascending paralysis. Kretzschmar (1971) separated 4 pyrones in order to study their sedative, cortical and subcortical activity on anaesthetized rabbits. All the pyrones were injected and showed a strong centrally caused muscle relaxing activity. He concluded that his results indicated that the sedative effect of the drug in man probably is the consequence of both depression of muscle tone and of the cortical activation system and limbic areas of the kava pyrone. From the above examples it would seem that separation of the active pyrones and injection rather than ingestion would benefit further research on the chronometric analysis of the effects of kava. However, the lack of agreement as to the number of pyrones that are active is an area of kava research needing further experimentation.

A number of improvements to the experiment are necessary before further study on the effects of kava upon alertness can be undertaken. First, as mentioned, kava constituents may need to be separated before measuring the dosage. Second, for greater standardization, subjects should be tested at the same time of day. If injection of kava pyrones is not possible a stipulation should be made that no food be eaten for a period of time prior to commencing the experiment in order to ensure that rate of uptake of pyrones from the gut is not an extraneous variable. Finally, in order to remove any increased motivational factors due to kava, it may be of benefit to use a placebo control group in addition to the kava experimental group.

No conclusions relevant to the safety or effects of social drinking in the Islands can be made from the results of the present experiment. In the Islands, kava is drunk by natives and migrants. Social drinking is different to rutual drinking in that the participants drink for prolonged periods, e.g., all night. Reports also suggest that with regular consumption of kava, the users develop a greater sensitivity to its effects, (Steinmetz 1960).

Because the present experiment does not test any progressive effects of continued drinking, no statements can be made regarding the effects upon the Island population.

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APPENDICES

TABLE 1

Reaction times (in msec) for alerting experiments over type of match, warning interval and sessions for Experiments 1 and 2.

EXPERIMENT 1		WARNING INTERVALS				
		1	2	3	4	5
No kava pretest	PI	583.2*	581.7	535.2	536.6	553.7
	NI	761.2	763.8	702.8	676.3	712.1
	D	749.1	704.6	725.1	705.4	705.2
No kava Posttest	PI	524.2	514.7	497.5	484.8	488.8
	NI	657.8	657.0	630.8	576.8	589.0
	D	656.8	626.3	629.9	604.9	612.0
Kava Pretest	PI	582.2	614.3	546.9	544.5	583.9
	NI	744.1	741.0	679.2	665.6	682.9
	D	757.1	727.6	723.2	700.0	711.4
Kava Posttest	PI	505.8	493.2	486.5	472.0	486.1
	NI	654.2	624.5	591.7	570.1	589.5
	D	607.7	596.5	599.2	585.1	575.3
EXPERIMENT 2						
Kava Pretest	PI	501.9*	504.7	467.3	471.1	488.7
	NI	659.4	627.4	592.6	596.7	599.0
Kava Posttest	PI	457.3	457.6	443.8	432.4	447.8
	NI	602.6	554.7	537.6	527.0	541.8

* msec.

TABLE 2

Percentage of trials over type of match, warning interval and sessions in which an erroneous response was made.

		1	2	3	4	5
EXPERIMENT 1						
No kava	PI	1.2	1.2	2.4	0.6	1.2
Pretest	NI	7.2	7.8	4.2	1.8	7.2
	D	2.4	4.5	2.1	1.2	2.1
No kava	PI	2.4	1.8	2.4	3.6	1.8
Posttest	NI	7.2	10.2	7.2	9.0	6.6
	D	2.7	0.8	3.9	6.3	3.0
Kava	PI	1.2	0.8	3.9	6.3	3.0
Pretest	NI	13.2	10.8	13.8	10.2	11.4
	D	6.6	6.9	6.9	9.9	6.0
Kava	PI	1.2	2.4	3.0	2.4	0.6
Posttest	NI	12.0	9.0	10.2	12.0	12.0
	D	6.3	6.6	9.0	7.2	6.6
EXPERIMENT 2						
Kava	PI	3.0	2.4	3.0	1.2	3.0
Pretest	NI	10.2	9.0	6.6	9.0	13.2
Kava	PI	1.8	2.4	4.2	2.5	2.4
Posttest	NI	9.0	9.0	13.8	9.0	12.6

TASK INSTRUCTIONS

The Task: Your task in this experiment is to indicate whether pairs of letters have the same name (e.g., AA, Aa, bB, gg, etc.,) or have different names (e.g., AB, Ab, gB, af, etc.). The letters will be presented on the computer screen. If the letters have the same name, push the key labelled "same", if they have different names push the "different" key.

The sequence of events will be as follows:

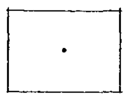
1. Pause. You will see the following message on the screen:

   THIS IS A REST PERIOD

   TAKE A PAUSE

   PRESS ANY KEY TO BEGIN AGAIN

2. Dot. When you press a key, the message will disappear and be replaced by a dot in the middle of the screen like so



3. Warn. After a few seconds a large cross will flash on the screen and at the same time you will hear a brief tone. These serve to warn you that a pair of letters is about to appear.

4. Letters/Respond. The letters appear and remain displayed until you press a key.

5. Feedback. After you have pressed a key a feedback message will appear on the screen. If you pressed the wrong key, the word "ERROR" will appear. If you pressed the correct key, a number (e.g., 526 ms) will appear. The number is your response time in miliseconds (a milisecond is a thousandth of a second). The faster you respond, the smaller these numbers will be.

6. Dot. The feedback message will disappear and the dot will appear again and remain on for several seconds. The sequence: dot, warning, letter pair, response, feedback, dot etc, will be repeated many times until a rest pause message appears. Do you have any questions about the sequence of events?

Speed/Accuracy. In this experiment it is important that you press the keys as quickly as you can after the letters appear, while not making lots of errors. Your aim is to get the numbers displayed after your key press as small as possible without making more than about 5-10 percent errors.

Getting Started: When you are ready to begin, just push one of the keys. Remember, respond as quickly as you can without making too many errors. There will be 8 blocks of trials altogether.

Experiment expected to take 45 mins.